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Tobe

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[54] **MEDICATION FILLING APPARATUS**

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[73] Assignee: **Sanyo Electric Co., Ltd.**, Osaka, Japan

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[30] **Foreign Application Priority Data**

Aug. 23, 1995 [JP] Japan 7-237602

[51] **Int. Cl.**^{6} **B65G 47/44**; B65B 57/20

[52] **U.S. Cl.** **53/501**; 53/237; 53/238; 364/479.14; 221/3

[58] **Field of Search** 364/478.04, 479.12, 364/479.13, 479.14; 221/2, 3, 1, 7, 123, 8; 53/25, 154, 155, 237, 238, 168, 268, 473, 493, 500, 501

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Primary Examiner—W. Donald Bray

Attorney, Agent, or Firm—Darby & Darby

[57] **ABSTRACT**

A medication filling apparatus which is capable of preventing medications from being over-dispensed so as to enable accurate filling operation. The medication filling apparatus is equipped with: a tablet case for holding medications; a dispenser drum for dispensing the medications one at a time from the tablet case as it rotates; a motor for driving and rotating the dispenser drum; a sensor for detecting the medications which have been dispensed; and a controller which starts the motor, counts the dispensed medications according to an output of the sensor, and stops the motor when a predetermined count value is reached. The controller drops the voltage applied to the motor before the predetermined count value is reached and then short-circuits the terminals of the motor when the predetermined count value is reached.

4 Claims, 13 Drawing Sheets

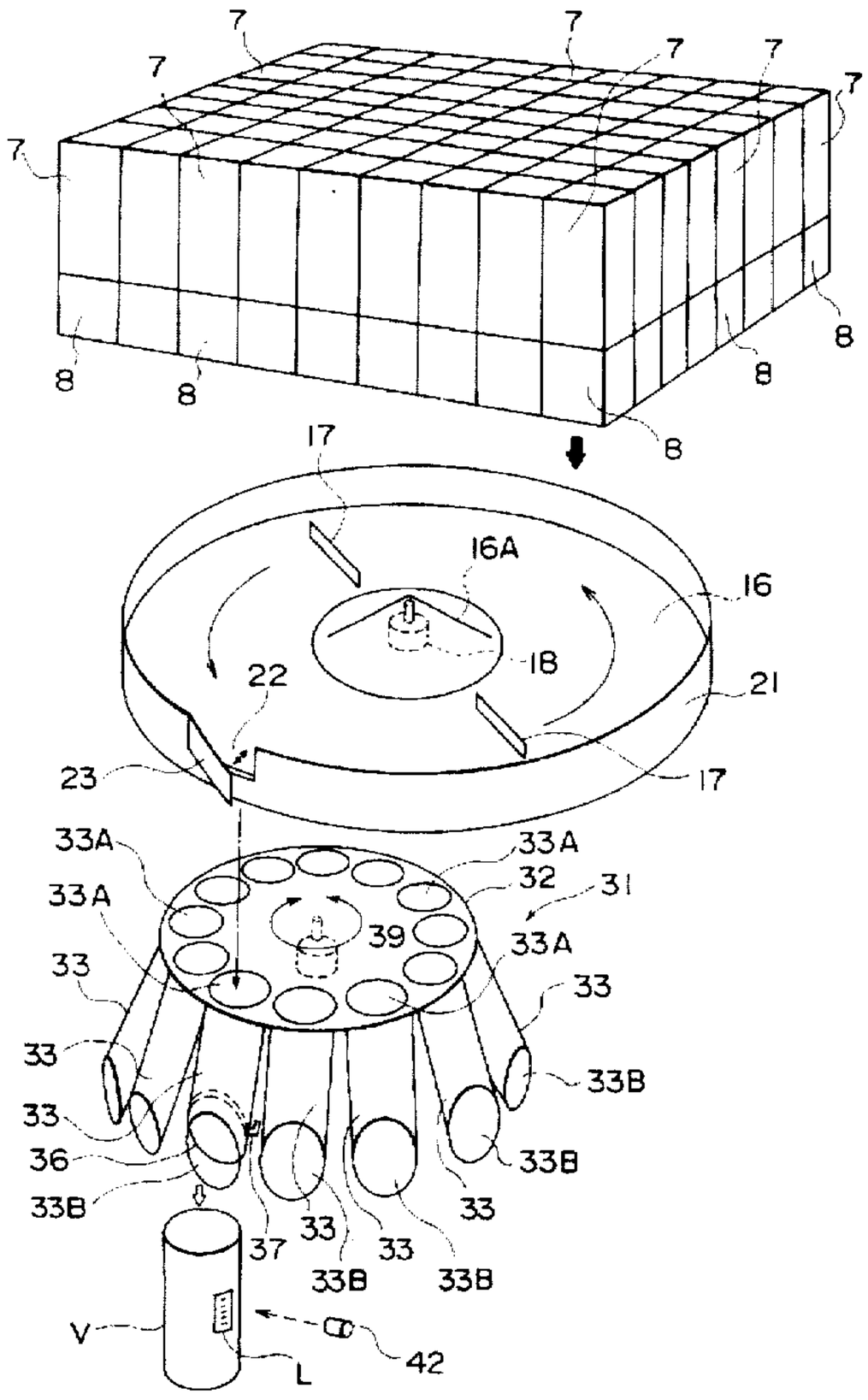


FIG. 1

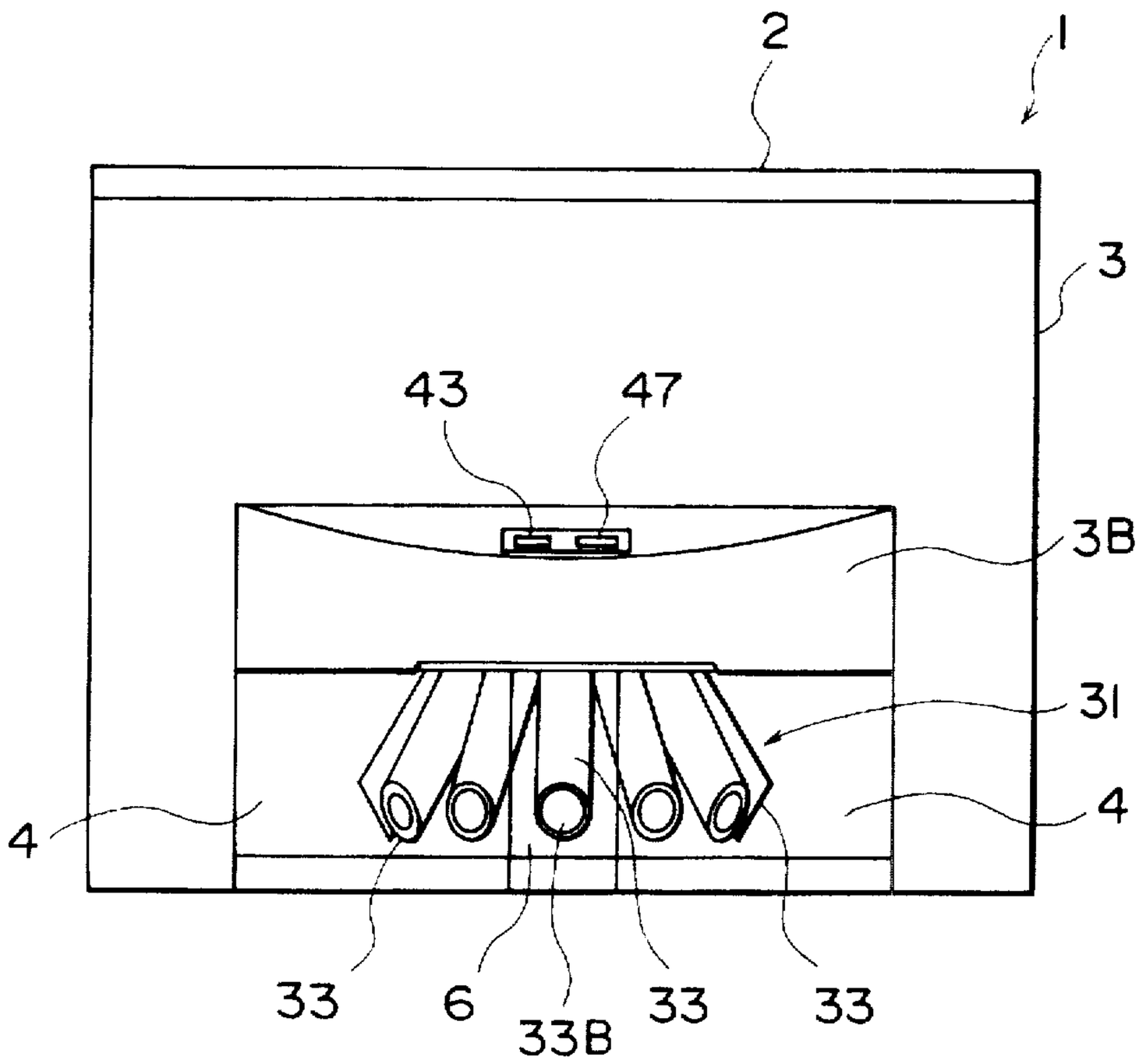


FIG. 2

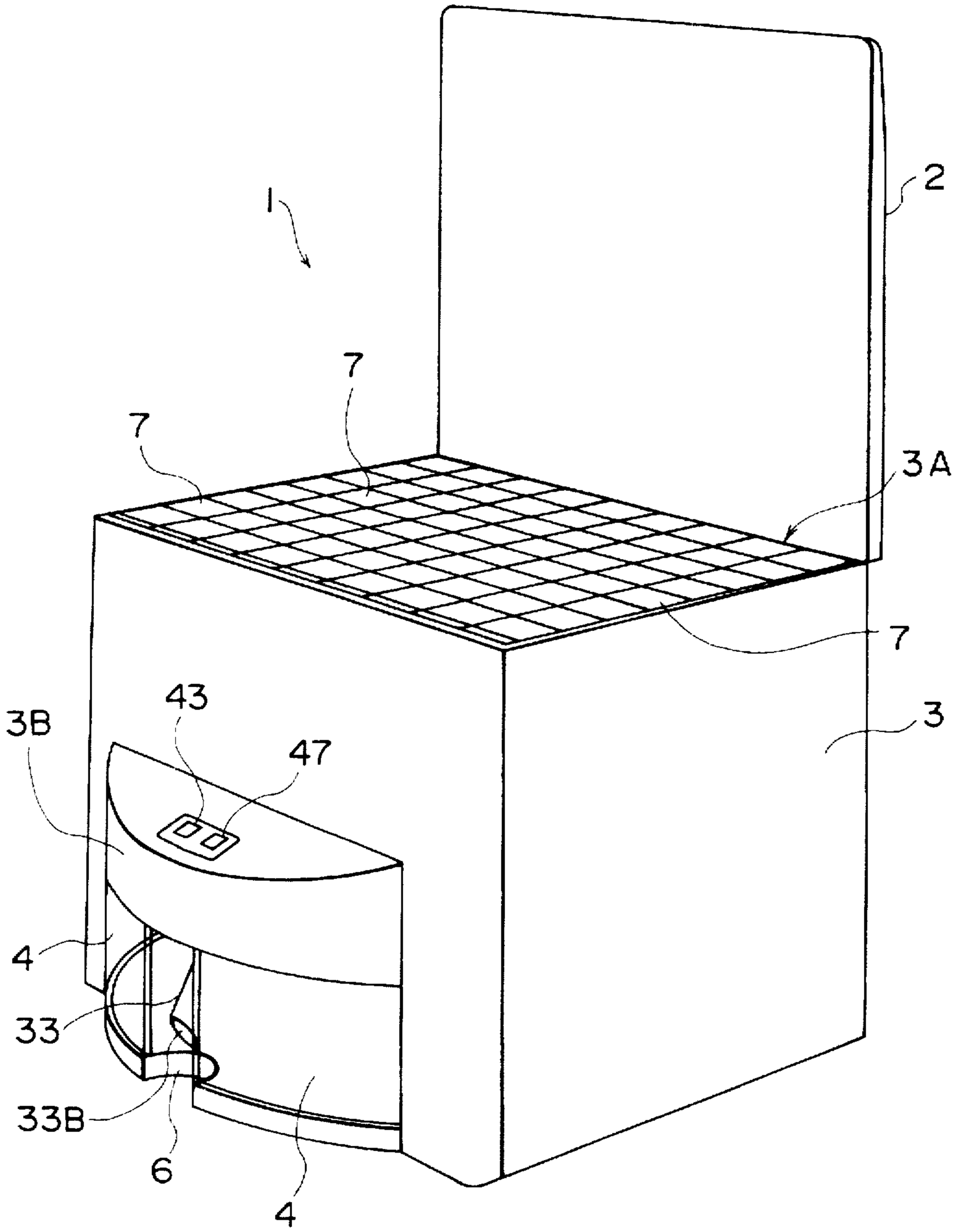


FIG. 3

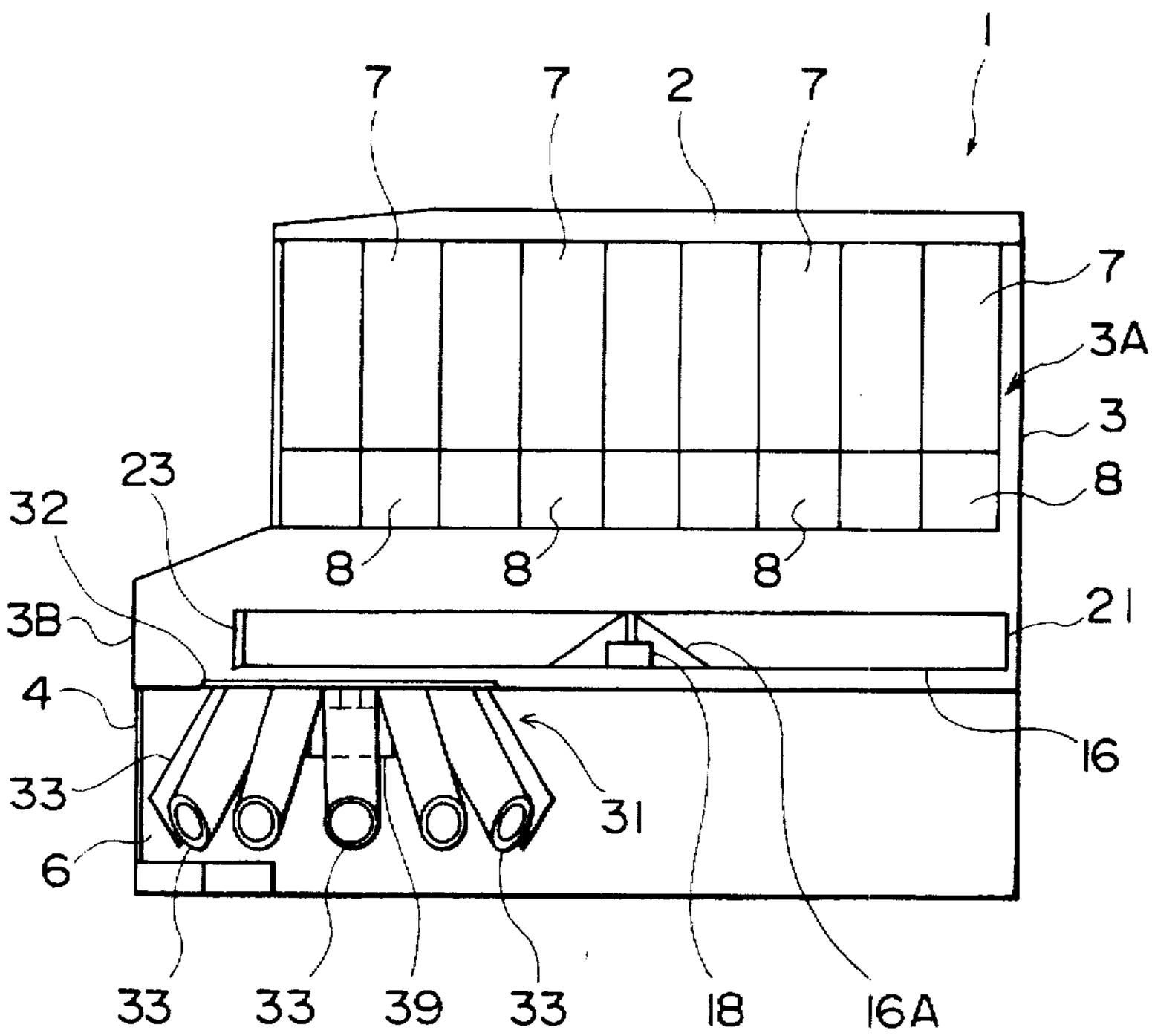


FIG. 4

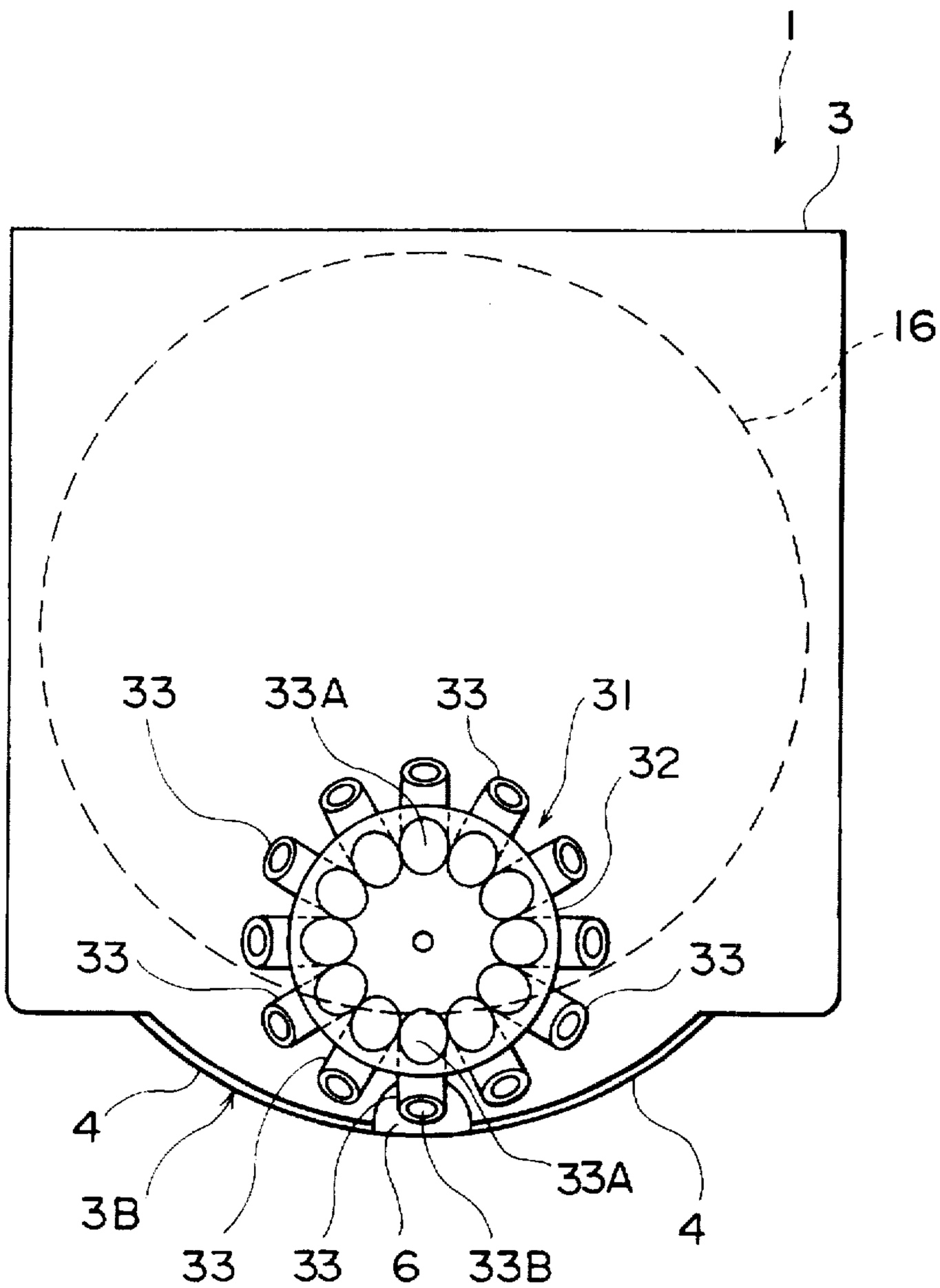


FIG. 5

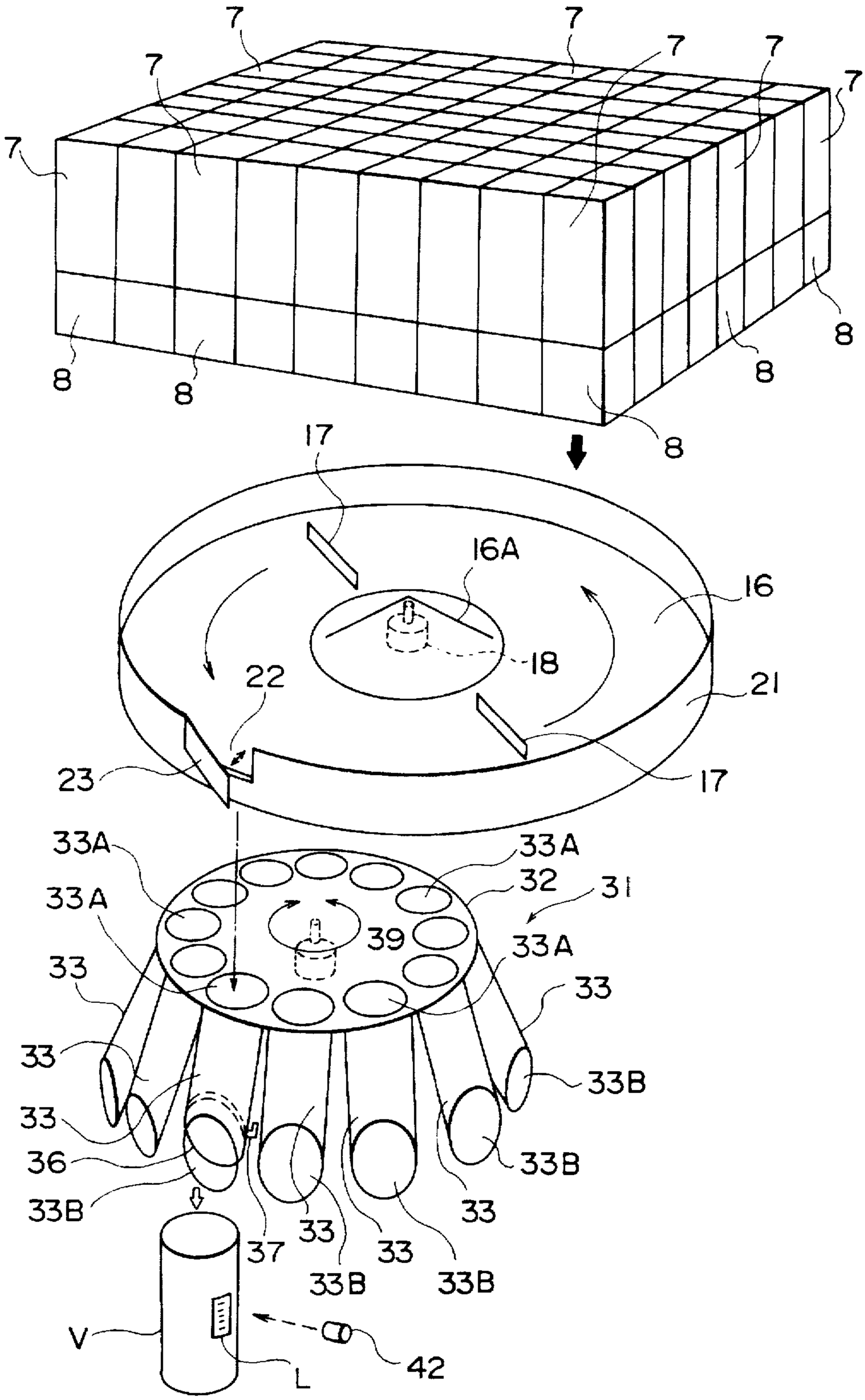

7
7
7
7
7
7
7
8
8
8
8
8
17
16A
16
18
22
21
23
17
33A
33A
33A
32
31
33A
39
33
33
33
33B
33
33B
36
33B
33
33
33
37
33B
33B
V
L
42

FIG. 6

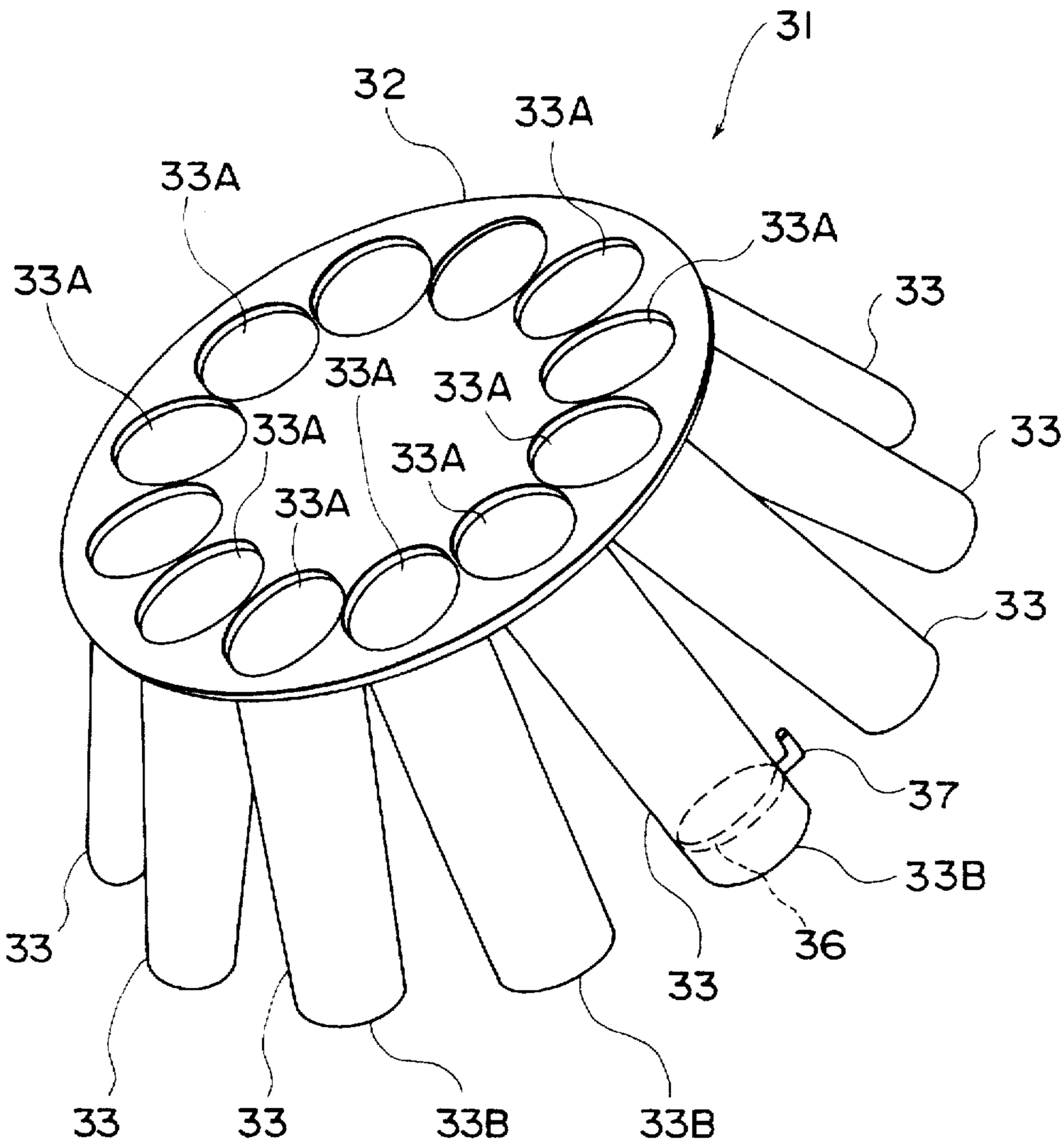

31
32
33A
33A
33A
33A
33A
33A
33A
33A
33A
33
33
33
33
33
37
33B
36
33
33
33
33B
33B

FIG. 7

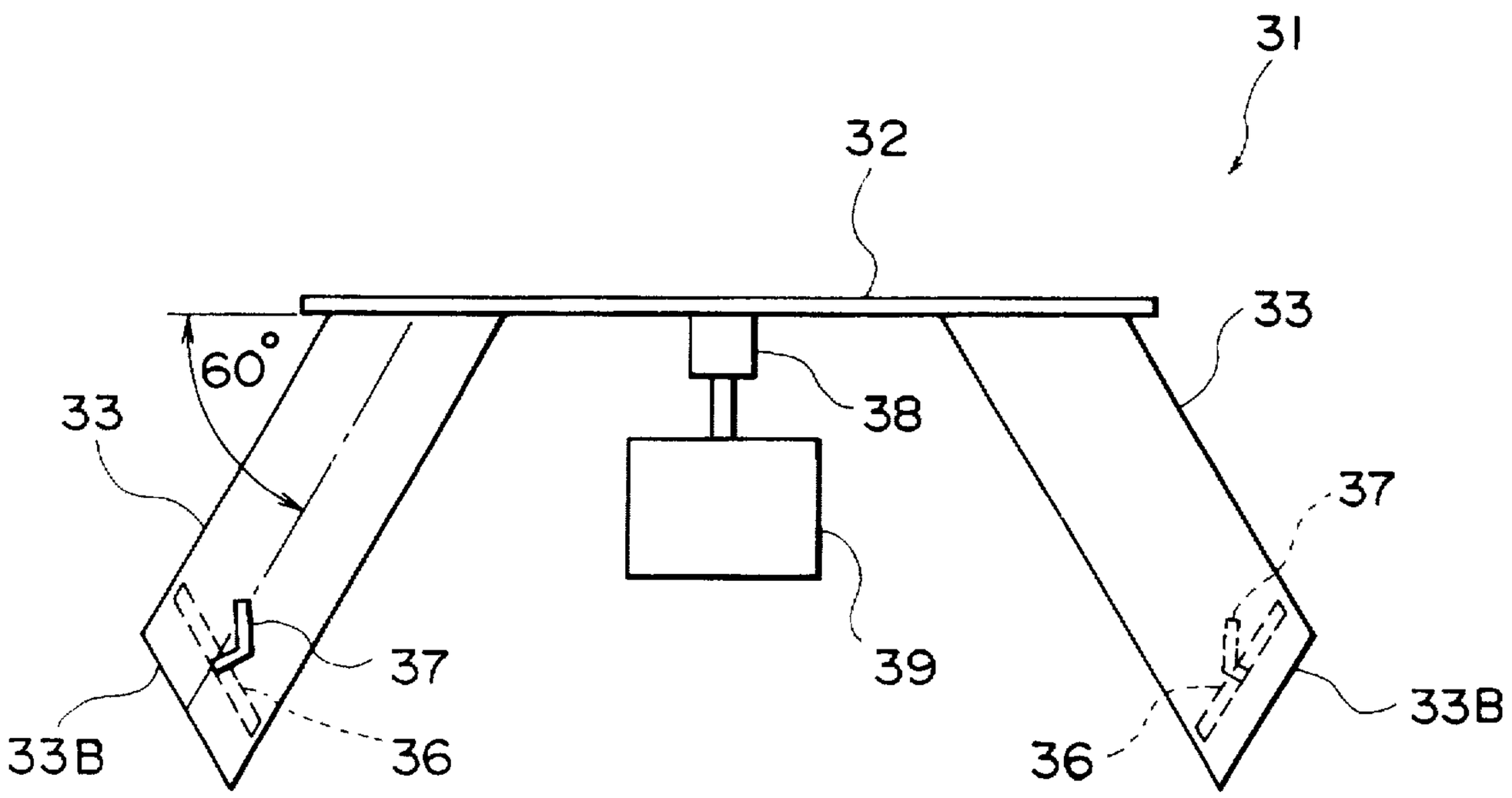


FIG. 8

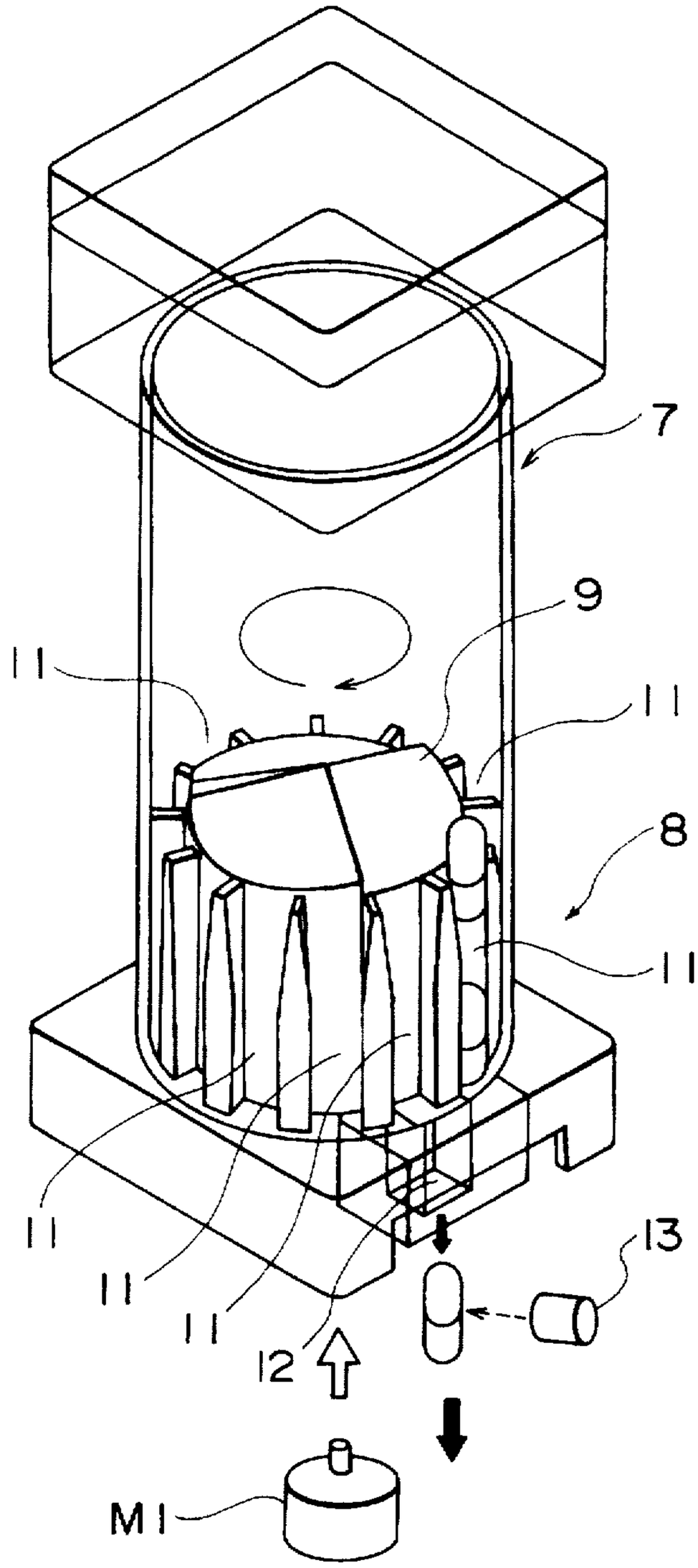


FIG. 9

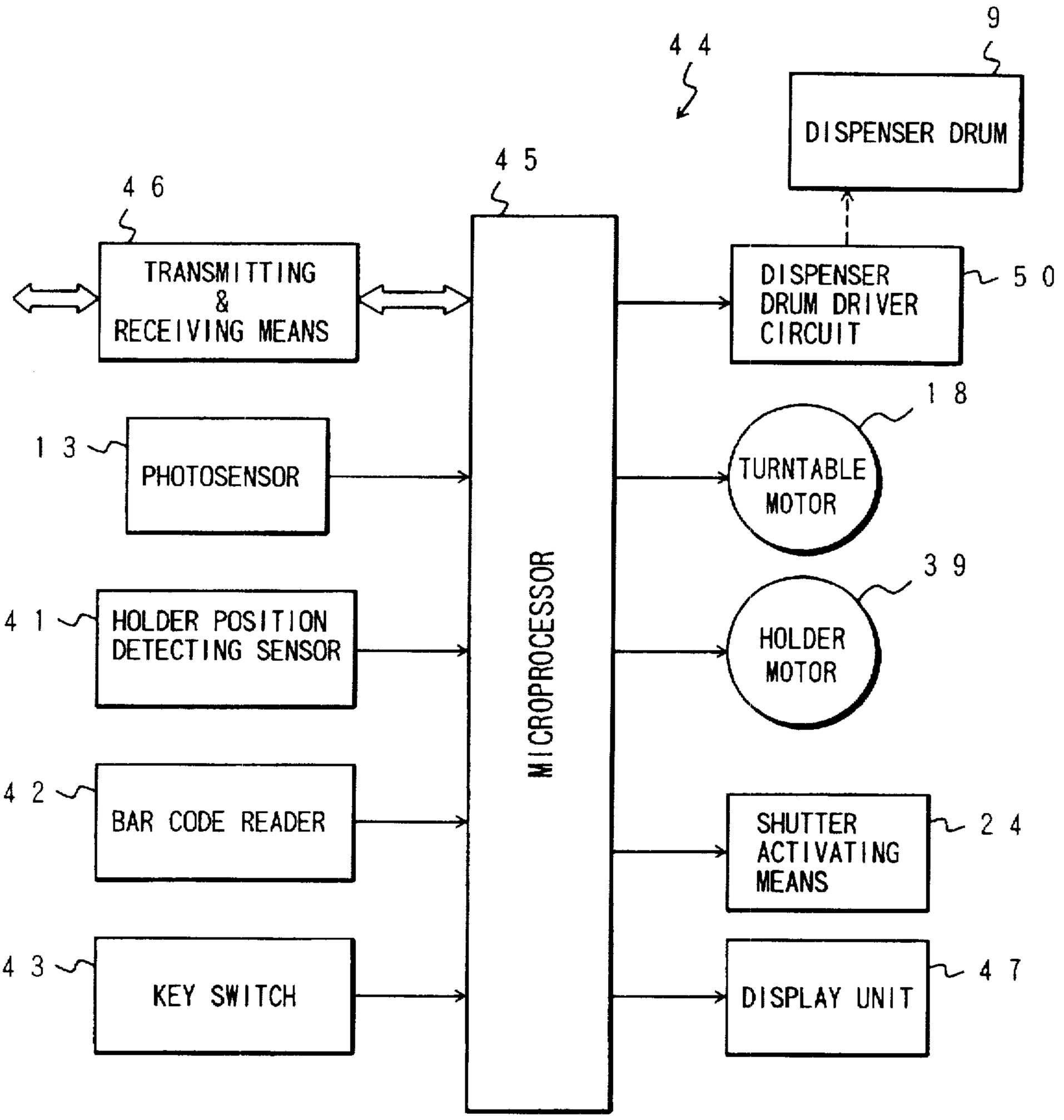

44
9
DISPENSER DRUM
45
46
TRANSMITTING & RECEIVING MEANS
DISPENSER DRUM DRIVER CIRCUIT
50
18
13
PHOTOSENSOR
TURNTABLE MOTOR
39
41
HOLDER POSITION DETECTING SENSOR
HOLDER MOTOR
MICROPROCESSOR
42
BAR CODE READER
SHUTTER ACTIVATING MEANS
24
43
KEY SWITCH
DISPLAY UNIT
47

FIG. 10

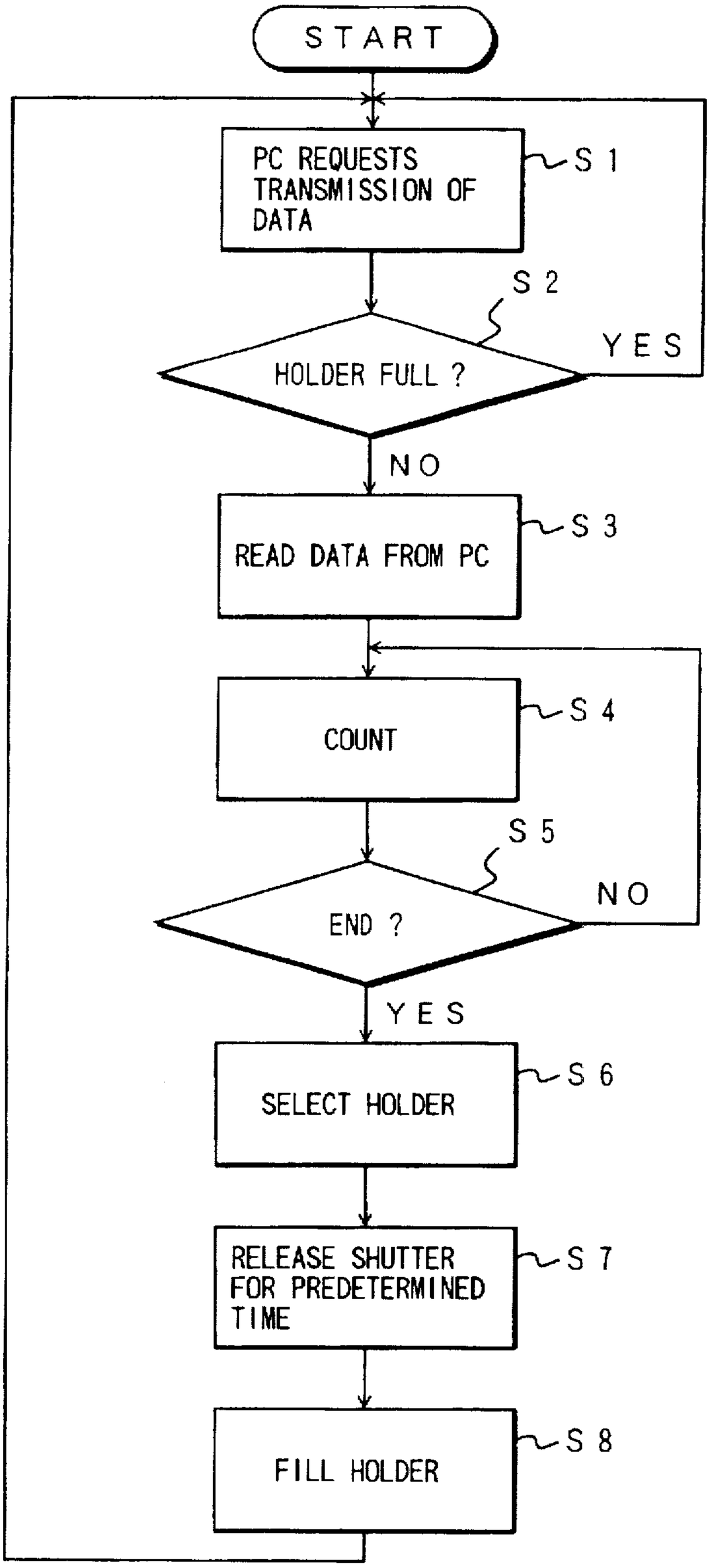

START
PC REQUESTS TRANSMISSION OF DATA
S 1
S 2
HOLDER FULL ?
YES
NO
READ DATA FROM PC
S 3
COUNT
S 4
S 5
END ?
NO
YES
SELECT HOLDER
S 6
RELEASE SHUTTER FOR PREDETERMINED TIME
S 7
FILL HOLDER
S 8

FIG. 11

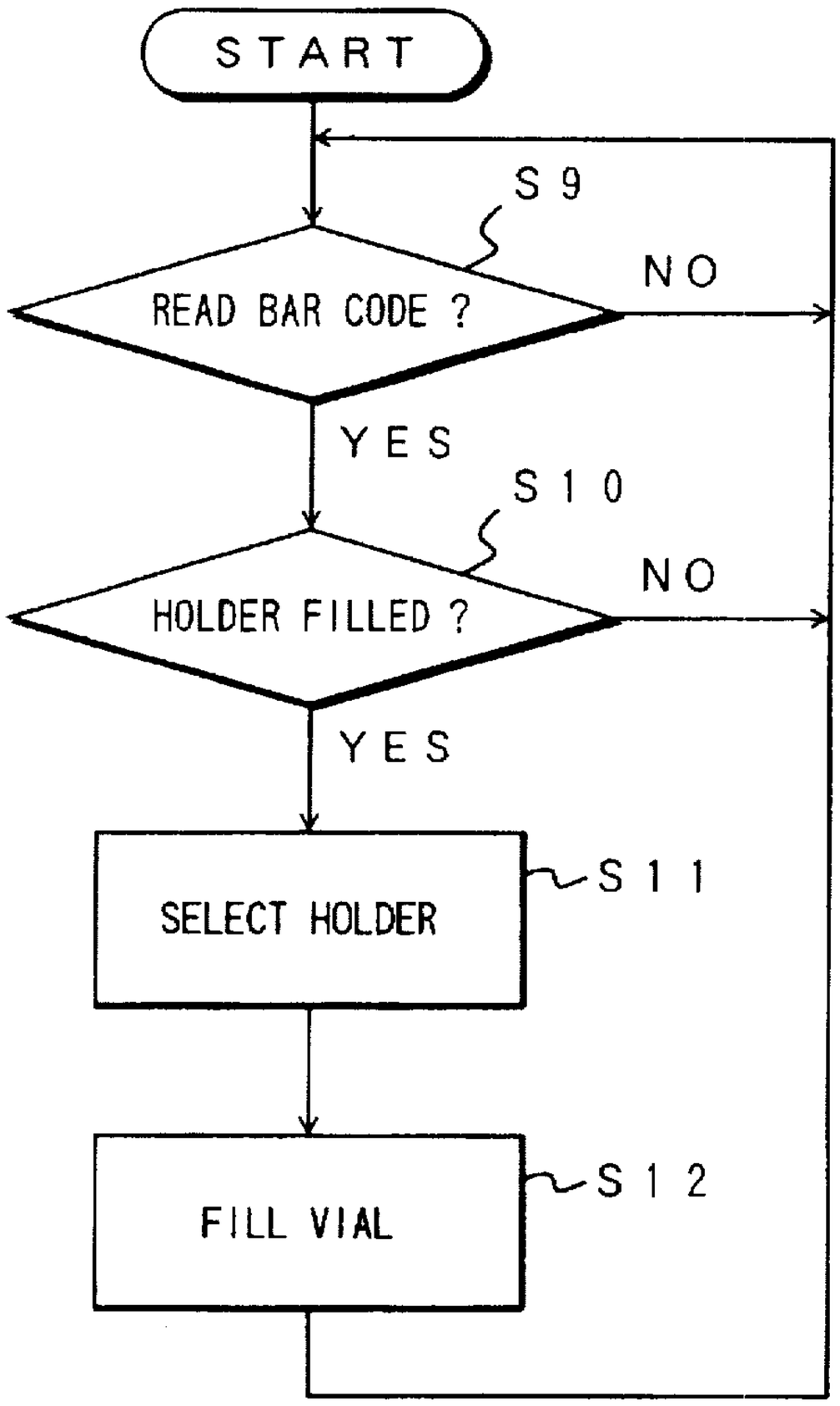

START
S 9
READ BAR CODE ?
NO
YES
S 1 0
HOLDER FILLED ?
NO
YES
SELECT HOLDER
S 1 1
FILL VIAL
S 1 2

FIG. 12

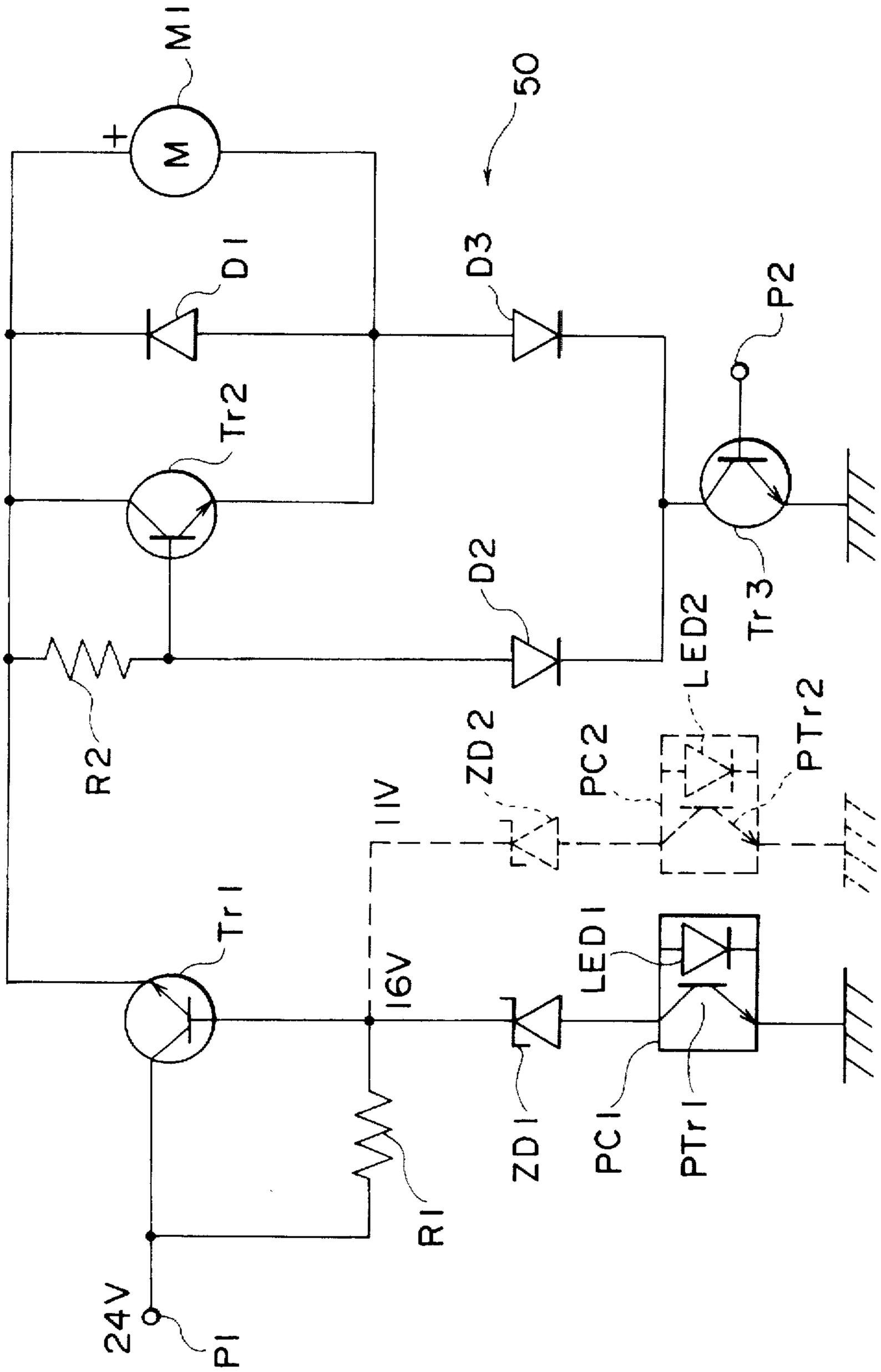
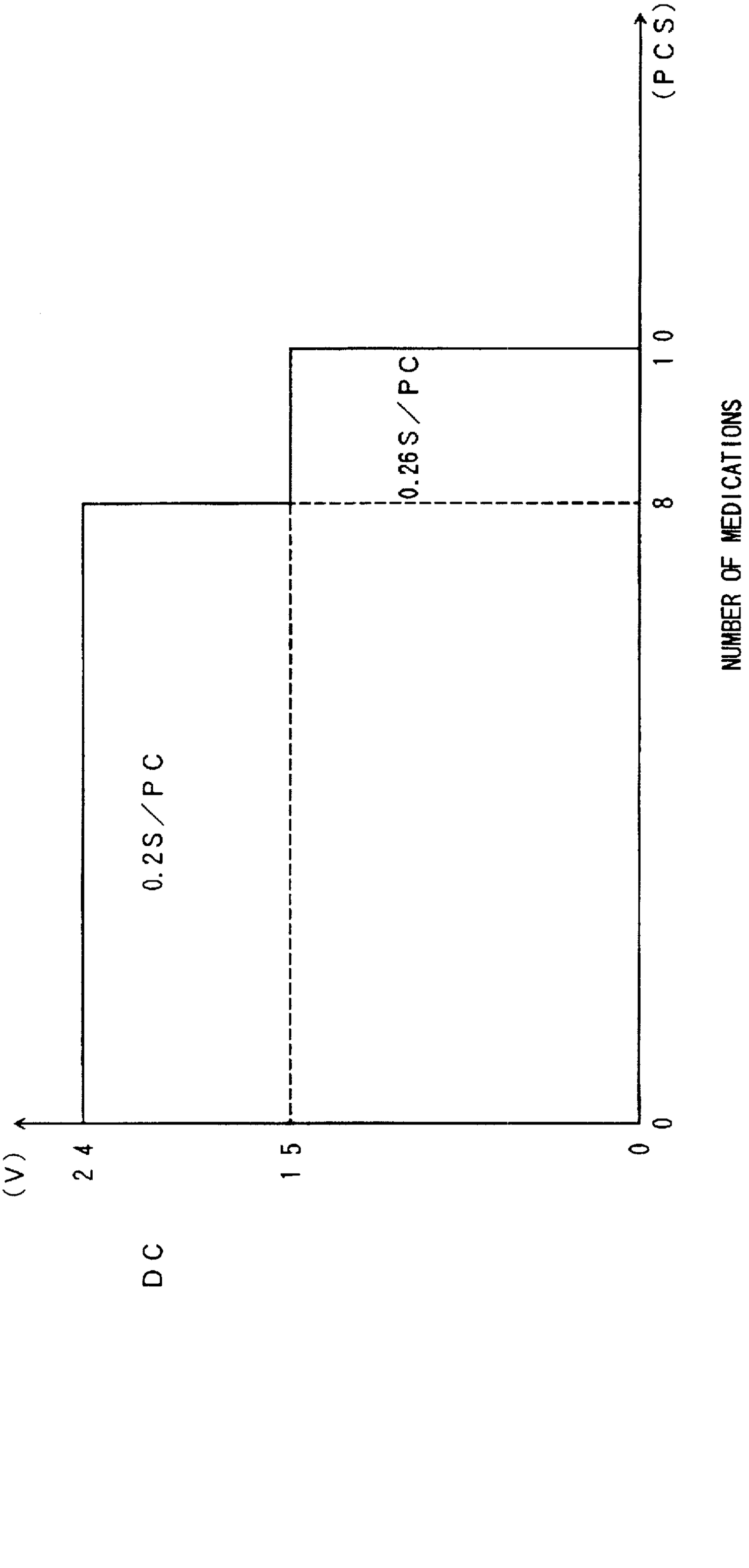

M1
+
M
D1
D3
Tr2
D2
P2
Tr3
LED2
R2
ZD2
PC2
PTr2
11V
Tr1
16V
LED1
ZD1
PC1
PTr1
R1
24V
P1

FIG. 13



MEDICATION FILLING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a medication filling apparatus for filling a container such as a vial, bag, or packaging paper with medications (the medications hereinafter mean tablets, capsules, pills, lozenges, and any other solid medications) specified by a prescription at a hospital or the like.

2. Description of the Related Art

Conventionally, at a hospital or the like, a plurality of types of tablets or medications prescribed by a doctor are packaged by dividing them for each dose by using a tablet packaging machine disclosed, for example, in Japanese Patent Publication No. 3-59 (A61J3/00) before supplying them to a patient. In some cases, prescribed tablets are placed in containers such as vials or bags by each type of tablets before they are handed to a patient.

In such a machine, the medications charged in a tablet case are dispensed one by one as a dispenser drum rotates, the dispensed medications are counted according to the outputs of a sensor which detects the dispensed medications, and a motor for driving the dispenser drum is stopped when a predetermined count value is reached. This means that the motor is driven by applying a predetermined voltage thereto to maintain a constant rotational speed of the dispenser drum until the predetermined count value is reached; then as soon as the predetermined count value is reached, the application of the voltage to the motor is stopped.

The dispenser drum, however, cannot stop immediately when the application of the voltage to the motor, which drives the dispenser drum, is stopped. Therefore, the dispenser drum overruns, posing a problem in that the number of actually dispensed medications exceeds the aforesaid predetermined count value in some cases.

Especially when the rotational speed of the dispenser drum is increased in an attempt to shorten the time required for charging the medications, the chances of the over-dispensing caused by the overrun increase.

SUMMARY OF THE INVENTION

The present invention has been made to solve the technical problem with the prior art described above and it is an object of the invention to provide a medication filling apparatus which is capable of preventing over-dispensing of medications so as to assure accurate filling operation.

To this end, according to the present invention, there is provided a medication filling apparatus which includes: a tablet case for holding medications; a dispenser drum for dispensing the medications one at a time from the tablet case as it rotates; a motor for driving and rotating the dispenser drum; a sensor for detecting the medications which have been dispensed; and a controller which starts the motor, counts the dispensed medications according to an output of the sensor, and stops the motor when a predetermined count value is reached. The controller drops the voltage applied to the motor at a value before reaching the predetermined count value.

In addition to dropping the voltage applied to the motor at the value before reaching the predetermined count value, the controller short-circuits a motor terminal when the predetermined count value is reached.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view showing a medication filling apparatus in accordance with the present invention;

FIG. **2** is a perspective view showing a top table of the medication filling apparatus in accordance with the present invention, the top table being in an opened state;

FIG. **3** is a longitudinal sectional side view showing the medication filling apparatus in accordance with the present invention;

FIG. **4** is a top sectional view showing the medication filling apparatus in accordance with the present invention;

FIG. **5** is an explanatory view showing the internal configuration of the medication filling apparatus in accordance with the present invention;

FIG. **6** is a perspective view showing a holder unit;

FIG. **7** is a side view showing the holder unit;

FIG. **8** is a perspective view showing a tablet case and a dispensing and counting device;

FIG. **9** is a block diagram showing a controller of the medication filling apparatus in accordance with the present invention;

FIG. **10** is a flowchart showing a program of a microprocessor;

FIG. **11** is another flowchart showing the program of the microprocessor;

FIG. **12** is an electric circuit diagram of the dispenser drum driving circuit of the dispensing and counting device; and

FIG. **13** is a diagram illustrative of a relationship between the number of medications dispensed and the voltage applied to the motor for driving the dispenser drum.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will now be described in detail with reference to the accompanying drawings.

A medication filling apparatus **1** according to the present invention is intended to be installed at a hospital, pharmacy, or the like. A tablet case assembly **3A** is disposed at the top inside a rectangular outer case **3**; the tablet case assembly **3A** is open upward and provided with a top table **2** which opens and closes the tablet case assembly **3A**. A filling section **3B**, which has an arc-shaped section, projects at the front of the outer case **3**. Transparent glass panels (or acrylic panels or the like) **4**, **4**, which have arc-shaped sections, are installed on both sides on the front surface of the filling section **3B** and an inserting opening **6** which is communicated with the filling section **3B** is provided between the transparent glass panels **4**, **4**.

A plurality of tablet cases **7** are arranged and housed in the tablet case assembly **3A**. The individual tablet cases **7** contain predetermined quantities of medications separately by type; dispensing and counting devices **8** are provided beneath the tablet cases **7** as shown in FIG. **8**.

The dispensing and counting devices **8** are respectively communicated with the tablet cases **7** located over them, a motor-driven dispenser drum **9** driven by a motor **M1** being incorporated therein. A plurality of vertical grooves **11** are formed from the top to bottom on the side surface of the dispenser drum **9**, so that solid medications such as tablets, capsules, pills, and lozenges (two pieces in this embodiment) are vertically aligned in each of these grooves. As the dispenser drum **9** rotates, the medications in each groove **11** drop one by one through an outlet **12** (as indicated by black arrows in FIG. **5** and FIG. **8**). The dispensing and counting device **8** is further provided with a photosensor **13** for detecting the medication which has dropped out through the outlet **12**.

A turntable **16** is provided in the outer case **3** under the tablet cases **7** and the dispensing and counting devices **8**. The turntable **16** is shaped like a disc and has an area which is sufficiently large to match the bottom area of all the tablet cases **7** and the dispensing and counting devices **8**. The turntable **16** has a projecting cone **16A** at the center thereof; there are also provided partitioning vanes **17**, **17** which extend in the radial direction from the projecting cone **16A**. A turntable motor **18** drives and rotates the turntable **16** in the direction of the arrows given in the drawing at a predetermined angular velocity.

An annular guide **21** is provided vertically around the turntable **16**; a notch-shaped dispensing port **22** is provided at the front end of the guide **21** to communicate the turntable **16** with the area outside the guide **21**. The dispensing port **22** is opened and closed by a shutter **23** which swings outward. The shutter **23** is driven by a shutter activating means **24** for a solenoid plunger or the like which will be discussed hereinafter. The vertical dimension of the turntable **16** including the guide **21** is approximately 10 cm.

Provided at the bottom front of the turntable **16** and the guide **21** is a holder unit **31**. As shown in FIG. **6** and FIG. **7**, the holder unit **31** is equipped with a disc base **32** at the top and a plurality of holders **33** (12 holders in the embodiment) which jut out from the base **32** and move down aslant (at 60 degrees in the embodiment). The top ends of the respective holders **33** are open through inlets **33A** provided in the base **32**; the bottom ends thereof are open through outlets **33B**.

Further, the respective holders **33** extend radially from the center of the base **32**; the respective inlets **33A** and the outlets **33B** are arranged on virtual circles which are concentric with the base **32**. The respective holders **33** are provided with covers **36** for opening and closing the respective outlets **33B** (only one cover is shown in FIG. **5** and FIG. **6**); and the covers **36** normally close the outlets **33B** by springs or the like which are not shown. Each of the covers **36** has a handle **37** sticking out of the holder **33** and the cover **36** is swung by the handle **37** to open the outlet **33B**.

A rotary shaft **38** juts out downward from the center of the base **32** of the holder unit **31**. A holder motor **39** is attached to the rotary shaft **38** and the holder unit **31** is driven and rotated by the holder motor **39**. The holder unit **31** is equipped with a holder position detecting sensor **41** for detecting the positions of the respective holders **33**, which will be discussed hereinafter.

Inside the filling section **3B** of the aforesaid outer case **3**, there is provided a bar code reader **42** which is located near the outlet **6**. Provided on the top surface of the filling section **3B** are a key switch **43** consisting of ten keys and a display unit **47** for showing preparing states including prescription data and for giving an alarm.

FIG. **9** is the block diagram showing a controller **44** of the medication filling apparatus **1** in accordance with the present invention. The controller **44** is comprised of a general-purpose microprocessor **45**. Connected to the microprocessor **45** is a transmitting and receiving means **46** for exchanging data with an external personal computer, which is not shown; connected to the input terminal thereof are the photosensors **13** of the dispensing and counting devices **8**, the holder position detecting sensor **41** of the holder unit **31**, the bar code reader **42**, and the key switch **43**. Connected to the output terminal of the microprocessor **45** are a dispenser drum driving circuit **50** of the dispensing and counting devices **8**, the turntable motor **18**, the holder motor **39**, the shutter activating means **24**, and the display unit **47**.

The dispenser drum driving circuit **50** is a control circuit for controlling the motor **M1** for driving the dispenser drum **9**. The details of the dispenser drum driving circuit **50** are shown in FIG. **12**. The collector of a transistor **Tr1** is connected to a 24VDC power supply **P1**; a resistor **R1** is connected between the collector and the base of the transistor **Tr1**. Connected to the base of the transistor Tr1 is a Zener diode **ZD1** for controlling the potential level of the connection terminal to 16 V. A phototransistor **PTr1** of a photocoupler **PC1**, which is comprised of the phototransistor **PTr1** and a light emitting diode **LED1**, is connected between the Zener diode **ZD1** and the ground. The light emitting diode **LED1** of the photocoupler **PC1** is connected to the output terminal of the microprocessor **45**.

Connected to the emitter of the transistor **Tr1** is a series circuit composed of a resistor **R2** and a diode **D2**; the series circuit is connected to the collector of a transistor **Tr3**. The emitter of the transistor **Tr3** is grounded while the base thereof is connected to a terminal **P2** which is connected to the output terminal of the microprocessor **45**. A series circuit composed of the motor **M1** and a diode **D3** is connected between the emitter of the transistor **Tr1** and the collector of the transistor **Tr3**. Connected across the terminals of the motor **M1** are the collector and emitter of the transistor **Tr2**. The base of the transistor **Tr2** is connected between the resistor **R2** and the diode **D2**; the diode **D1** is connected across the terminals of the motor **M1**.

The conducting direction of the diodes **D2** and **D3** is toward the transistor **Tr3**; for the diode **D1**, the conducting direction is toward the collector of the transistor **Tr2**. It is assumed that the dispenser drum driving circuit **50** is provided for the motor **M1** of each dispenser drum **9**.

The operation of the medication filling apparatus **1** which has the configuration described above will now be described. FIG. **10** shows a flowchart of the program for the microprocessor **45** to perform the medication dispensing operation; FIG. **11** shows another flowchart of the program for the microprocessor **45** to perform the medication charging operation. When the power is ON, the shutter **23** closes the dispensing port **22** of the guide **21** and the count value is reset. Electric currents are supplied to the turntable motor **18** at all times to drive the turntable **16** at all times. The turntable **16** may be temporarily halted when the preparing operation is interrupted for a predetermined time.

When an operator keys in prescription data to the personal computer according to a prescription given by a doctor, the personal computer requests the transmission of data from the medication filling apparatus **1**. As soon as the microprocessor **45** of the medication filling apparatus **1** receives the request for the data transmission from the personal computer through the transmitting and receiving means **46** in step **S1**, it determines in step **S2** whether all the holders **33** of the holder unit **31** retain and are full of medications; if it decides that they are full, then it goes back to step **S1** wherein it stands by.

If the microprocessor decides in step **S2** that the holders **33** are not filled up, then it responds, in step **S3**, to the personal computer, telling that it is ready to receive data and it receives and reads the prescription data sent from the personal computer. In step **S4**, based on the prescription data, the microprocessor **45** drives and rotates the dispenser drum **9** of the dispensing and counting device **8** of the tablet case **7** which holds the type of medication specified in the prescription data.

In this case, the microprocessor **45** first supplies electric currents to the terminal **P2** with the phototransistor **PTr1**

OFF, without supplying any electric currents to the light emitting diode ED1 of the photocoupler PC1 so as to turn ON the transistor Tr3. This causes electric currents to flow through the transistor Tr1, the motor M1, the diode D3, and the transistor Tr3 in the order in which they are listed and also causes a voltage of 24V to be applied to the motor M1 which runs at full speed. At this time, the transistor Tr2 is OFF because the voltage applied to the base thereof is dropped to a grounding potential level.

As the dispenser drum **9**, which is driven by the motor M1, rotates, the medications drop one by one as previously mentioned; the dispensing speed is 0.2 sec/pc as illustrated in FIG. **13**. The dropped medications are received by the turntable **16**. The released medications are counted by the microprocessor **45** through the photosensor **13**. In step S5, the microprocessor determines whether the counting has been completed; if the determination result is negative, then it goes back to step S4 to repeat the same process.

In the course of repeating the process, when a value (8 in this embodiment) before reaching the number of medications (10 in this embodiment) specified in the prescription data is reached, the microprocessor **45** supplies electric currents to the light emitting diode LED1 of the photocoupler PC1 to turn ON the phototransistor PTr1. This limits the voltage appearing at the emitter of the transistor Tr1 to 15 volts by the Zener diode ZD1, thus reducing the speed of the revolting motor M1 so that the dispensing speed is reduced to 0.26 sec/pc.

As soon as the number of dropped medications detected by the photosensor **13** reaches the specified number of medications, namely, ten, based on the prescription data, the microprocessor **45** stops the output to the terminal P2 and turns OFF the transistor Tr3. This stops the supply of electric currents to the motor M1, while at the same time turns ON the transistor Tr2 to short-circuit both terminals of the motor M1 through the transistor Tr2. Thus, back electromotive force produced by the overrun of the motor M1 is consumed by the coils, etc., enabling the motor M1 to make a sudden stop immediately when braking is engaged.

The microprocessor **45** then advances from step S5 to step S6 shown in FIG. **10**.

The medications which have dropped onto the turntable **16** move toward the guide **21** located on the circumference of the turntable **16** due to the centrifugal force of the turntable **16**. At this time, since the projecting cone **16A** is located at the center of the turntable **16** at which the centrifugal force is weaker, the medications dropped onto the center move outward along the slope of the projecting cone **16A** and then move toward the guide **21** owing to the centrifugal force. The partitioning vanes **17**, **17** provided on the turntable **16** turn with the turntable, so that the medications which stay stationary on the turntable **16** may be also pushed and moved outside smoothly. Thus the medications dropped onto the turntable **16** are collected and moved to the guide **21** and aligned, being pushed against the guide **21**.

Next, in step S6, the microprocessor **45** selects an empty holder **33**, drives the holder motor **39** to rotate the holder unit **31**, and positions the empty holder **33** under the dispensing port **22** of the guide **21** with the aid of the holder position detecting sensor **41**. Then in step S7, the microprocessor **45** swings the shutter **23** outward as shown in FIG. **5** by the shutter activating means **24** to release the dispensing port **22** for a predetermined time (e.g. 1 second) and then close it.

When the dispensing port **22** is released, the medications aligned against the inner circumferential wall of the guide **21** are collected at the dispensing port **22** one after another by the centrifugal force and moved into the holder **33** through the inlet **33A** of the holder **33** located below (step S8).

The microprocessor **45** repeats the procedure from step S4 to step S8 for all types of medications specified in the prescription data to fill the separate holders **33** with different medications.

The operator attaches a bar code label L, which carries the bar code indicating a patient identification code showing the name of the patient, a patient code, etc., the type name of the medications, and the quantity of the medications specified in the prescription data, to the side face of a vial V serving as the predetermined container. When the container is inserted into the filling section **3B** through the inserting opening **6** of the medication filling apparatus **1**, the bar code on the bar code label L is read through the bar code reader **42**. The microprocessor **45** determines in step S9 shown in FIG. **11** whether the bar code carrying the identification information such as the type of medication has been successfully read through the bar code reader **42**; if it decides that the bar code has been read properly, then it proceeds to step S10 wherein it decides whether the holder **33** has been filled with the specified type of medication. If the microprocessor finds that the holder has not yet been filled, then the microprocessor returns to step S9 wherein it stands by.

When the specified type of medications are charged in the holder **33** in step S8, the microprocessor **45** advances from step S10 to step S11 wherein it selects the holder **33** filled with the medications, drives the holder motor **39** to rotate the holder unit **31**, and positions the holder **33** at the inserting opening **6** with the aid of the holder position detecting sensor **41**.

Under the condition stated above, the port of vial V is positioned under the outlet **33B** of the holder **33** and the cover **36** is opened by the handle **37** to fill the vial V with the specified type of medications from the holder **33** (step S12).

Thus, according to the present invention, dispensed medications are counted according to the outputs supplied by the photosensor **13**; the moment the number of dispensed medications reaches 8 before the predetermined count value, namely, 10, is reaches, the voltage applied to the motor M1 for driving the dispenser drum **9** is lowered from 24 volts to 15 volts to decrease the running speed thereof; and when the predetermined count value is reached, the terminals of the motor M1 are short-circuited to eliminate the back electromotive force of the motor M1. Therefore, even when the running speed of the dispenser drum **9** is increased at an early stage to increase the medication dispensing speed, the overrun of the dispenser drum **9** can be controlled to prevent over-dispensing of the medications, thus assuring accurate medication filling.

In the embodiment described above, the voltage applied to the motor M1 is controlled in two steps. The voltage, however, may alternatively be controlled in three steps as described hereinafter. As indicated by dashed lines in FIG. **12**, a Zener diode ZD2 for controlling the connection terminal to 11 volts may be connected to the base of the transistor Tr1; and the phototransistor PTr2 of the photocoupler PC2 composed of the phototransistor PTr2 and the light emitting diode LED2 is connected between the Zener diode ZD2 and the ground. By controlling the light emitting diode LED2 of the photocoupler PC2 by the microprocessor **45**, the voltage applied to the motor M1 may be dropped to 15 volts when the count value reaches 6, then the light emitting diode LED2 is energized when the count value reaches 8 so as to drop the applied voltage further to 10 volts before the motor M1 is finally short-circuited.

As detailedly described above, according to the present invention, the voltage applied to the motor for driving the dispenser drum is dropped to reduce the motor running speed at a count value before reaching the predetermined count value. Further, when the predetermined count value is reached, the terminals of the motor are short-circuited so as to make the motor stop suddenly. With this arrangement, according to the present invention, the overrun of the dispenser drum can be effectively controlled, so that the over-dispensing of medications from a tablet case can be securely or effectively prevented, thereby enabling accurate filling operation to be achieved.

What is claimed is:

1. A medication filling apparatus comprising:

a tablet case for holding a plurality of medications;

a dispenser drum for dispensing the medications one at a time from said tablet case as it rotates;

a motor for driving and rotating said dispenser drum;

a sensor for detecting each of the medications which has been dispensed; and

a controller which starts said motor, counts the dispensed medications according to an output of said sensor and produces a count value, and stops said motor when a predetermined count value is reached; wherein

said controller decreases the voltage applied to said motor to reduce its speed of rotating said drum at a count value less than said predetermined count value.

2. A medication filling apparatus according to claim **1**, wherein said controller decreases the voltage applied to said motor in steps when a count value less than said predetermined count value is reached.

3. A medication filling apparatus comprising:

a tablet case for holding a plurality of medications;

a dispenser drum for dispensing the medications one at a time from said tablet case as it rotates;

a motor for driving and rotating said dispenser drum;

a sensor for detecting each of the medications which have been dispensed; and

a controller which starts said motor, counts the dispensed medications according to an output of said sensor and produces a count value, and stops said motor when a predetermined count value is reached; wherein

said controller decreases the voltage applied to said motor when a count value less than said predetermined count value is reached and then short-circuits the terminals of said motor when said predetermined count value is reached.

4. A medication filling apparatus according to claim **3**, wherein said controller decreases the voltage applied to said motor in steps when a count value less than said predetermined count value is reached.

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